Response Time Analysis for DWASP III

Mobile Communication Devices

June 1989

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FOREWORD

Increment III of the DLA Warehousing and Shipping Procedures (DWASP III) includes switching the depot functions of stock selection, stowage, inventory, stock surveillance, and transportation over to a paperless system. This will be accomplished by using Mobile Communication Devices (MCDs) to link warehouse workers with the depot mainframe computer. The volume of transactions between warehouse workers and the mainframe computer affects the mainframe response time. The DLA Depot Operations Division (DLA-OW) is concerned that the mainframe response time would be too slow to process a worst case workload. DLA-OW requested the DLA Operations Research and Economic Analysis Management Support Office (DLA-DORO) to perform a study to determine the maximum allowable mainframe response time and the minimum required number of MCDs that would allow Defense Depot Memphis Tennessee (DDMT) to process a worst case workload in one shift.

The maximum allowable mainframe response times are 11.2 seconds for programmable MCDs and 2.9 seconds for nonprogrammable MCDs. Using the DLA Systems Automation Center (DSAC) estimated worst case mainframe response time of five seconds, only programmable MCDs can successfully process a worst case workload. In addition, sensitivity analyses show that programmable MCDs allow for a greater margin of error in depot time standards, almost four times that of nonprogrammable MCDs. Therefore, programmable MCDs should be considered for all six depots. The analysis shows that the minimum number of programmable MCDs required by DDMT to process a worst case workload is 473. An additional 25 MCDs are required to be spares, for a total of 498 programmable MCDs at DDMT.

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I. INTRODUCTION

A. Background

Increment III of the DLA Warehousing and Shipping Procedures (DWASP III) includes switching the depot functions of stock selection, stowage, inventory, stock surveillance, and transportation over to a paperless system. This will be accomplished by using Mobile Communication Devices (MCDs) to link warehouse workers with the depot mainframe computer. The volume of transactions between warehouse workers and the mainframe computer affects the system response time (i.e., the more transactions the slower the response time). The system response time is divided into two parts: the response time from an enter key depression on an MCD to the communications controller via a base relay station and back to the MCD; and the response time from the communications controller to the mainframe computer and back to the communications controller. These portions of the system response time are referred to as the MCD response time and the mainframe response time, respectively.

The MCD response time is limited by the specification package, DLAH00-88-R-0036 (SPEC), to 2.5 seconds. The mainframe response time is determined by the size of computer the depot will be using and the total number of transactions the computer handles (to include other depot transactions). DLA-OW is concerned that the mainframe response time would be too slow to process a worst case workload, as outlined in the SPEC, in one shift with the number of MCDs that are being procured.

Accordingly, the DLA Depot Operations Division (DLA-OW) requested the DLA Operations Research and Economic Analysis Management Support Office (DLA-DORO) to perform a study to determine the maximum mainframe response time that would allow Defense Depot Memphis Tennessee (DDMT) to process a worst case workload in one shift.

B. Purpose

The primary purpose of this study was to determine the maximum mainframe response time that will permit a worst case workload to be processed in one shift. DLA-OW plans to compare this result with the projected mainframe response time, to be provided by the DLA Systems Automation Center (DSAC), to see if the currently projected mainframe computer resources are sufficient.

A secondary purpose of this study was to predict the minimum number of MCDs required by DDMT to process a worst case workload in one shift given different system response times.

C. Objectives. The specific objectives of the study were to:

1. Determine the maximum mainframe response time which allows a worse case workload to be accomplished in one shift.

2. Determine the minimum number of MCDs required to complete a worst case workload given different system response times (i.e., mainframe response time plus MCD response time).

D. Scope

1. Time permitted only one of the six depots to be evaluated. DDMT was chosen since it is one of the largest depots and may pose the biggest problem during the conversion to MCDs.

2. Only the worst case workloads as defined in the SPEC and DDMT's average workloads were examined.

3. Programmable (smart) and non-programmable (dumb) MCDs were considered. Smart MCDs are required by the SPEC.

E. Limitations. This study pertains to DDMT specifically, and the maximum allowable mainframe response times and the minimum number of MCDs required should not be extrapolated to the other five depots. The calculations are based on DDMT composite time standards provided by the DLA Performance Standards Support Office (DPSSO). These time standards are detailed in Table 1. Assuming the use of MCDs will yield faster work times, then these time standards provide an upper bound on time between transactions since they are based on present work habits. Thus, the results are conservative, and are only as good as these standards.

II. CONCLUSIONS

The maximum allowable mainframe response times are 11.2 seconds for smart MCDs and 2.9 seconds for dumb MCDs, given worst case workloads and 7.0 productive hours in a shift. A worst case workload can be processed with smart MCDs. However, a worst case workload can not be processed with dumb MCDs considering the DSAC estimated mainframe response time of five seconds. In addition, smart MCDs provide a greater margin for error, almost four times that of dumb MCDs. Thus, smart MCDs are required at DDMT to process a worst case workload.

Given a system response time of 7.5 seconds (a DSAC estimated five second mainframe response time, and a 2.5 second SPEC driven MCD response time), the minimum number of smart MCDs required to process a worst case workload and an average workload is 473 and 382 MCDs, respectively. Additional MCDs are required to satisfy the SPEC requirement that 5% of the MCDs are to be spares.

The number of MCDs to assign each functional area should be based on an average workload. This would provide enough MCDs for each functional area to handle the workload, even if daily workloads increase.

III. RECOMMENDATION

A. As was called for in the SPEC, smart MCDs should be procured for DDMT. To ensure compatability between depots, smart MCDs should be procured for the other five depots.

B. A total of 498 smart MCDs should be procured for DDMT (five more than planned); 473 MCDs will handle a worst case workload and 25 MCDs to be used as spares.

C. The 473 MCDs should be distributed among the functional areas in proportion to the average workload.

IV. METHODOLOGY

A. Deterministic Model. Calculating the maximum mainframe response time and minimum number of MCDs was accomplished using a simple deterministic model.

1. The maximum mainframe response time for a functional area is calculated as follows:

$$(TRANS * RT) + (ACT * AT) = ST * MCD \qquad (1)$$

where,

TRANS = number of transmissions
RT = system response time
(MCD + Mainframe response time)
ACT = number of activities (e.g., MROs)
AT = time to perform the activity (time standard)
ST = productive time during shift (e.g., 7.5 hours)
MCD = number of MCDs assigned to the functional area

solving for RT,

$$RT = \frac{(ST * MCD) - (ACT * AT)}{TRANS} \qquad (2)$$

the mainframe response time (MT) is obtained by,

$$MT = RT - MCDT \qquad (3)$$

where,

MCDT = MCD response time (assumed to be 2.5 seconds).

2. The minimum number of MCDs required by each functional area is obtained by rewritting equation 2 above.

$$MCD = \frac{(RT * TRANS) + (ACT * AT)}{ST} \qquad (4)$$

B. Assumptions. The number of variables required for obtaining a mainframe response time would have made the deterministic model cumbersome. So a few assumptions were made to limit the number of variables. These assumptions are as follows:

1. A shift has 7.5 productive hours.

2. The MCD response time is 2.5 seconds, which is the maximum allowed MCD response time as outlined in SPEC paragraph C 5.3.1.a.

3. That 493 MCDs are procured for DDMT as called for in attachment 2 of the SPEC with 10 being used as spares.

4. A smart M(can hold 10 transactions for every one down load from the mainframe computer.

5. The time it takes to perform an activity (i.e., stock selection) is accurately defined by the DDMT composite time standards. The time standards used in this study are listed in Table 1.

Table 1

DDMT COMPOSITE TIME STANDARDS

Standard Number	Title	Time (Min)
3335	Bin Issue	3.546
3330	Bin Stowage	4.938
3531	Bin Rewarehousing Issue	5.370
3532	Bin Rewarehousing Stow	2.694
3320	Bulk Issue	11.898
3251	Bulk Stowage	10.008
3536	Bulk Rewarehousing Issue	8.850
3537	Bulk Rewarehousing Stow	10.092
3501	Inventory	8.046
3521	Location Surveyed	1.374
3510 & 3515	Surveillance Inspection	30.681
3340, 3345, & 3310	Freight Terminal Proc.	4.622

C. Sensitivity Analyses

Two sensitivity analyses were performed on the maximum allowable mainframe response time by varying:

1. the type of MCD (smart versus dumb).

2. the productive hours in a shift from 7.5 hours to 7.0 hours to more realistically imitate a true work shift.

A 7.0 productive hour shift is based on an 8.5 hour shift minus 30 minutes for lunch, minus two 15 minute breaks, minus a 15 minute sign-on time at the beginning of shift, minus a 15 minute sign-off time at the end of shift.

Four sensitivity analyses were performed on the minimum number of required MCDs by varying:

1. the system response time from 0 to 10 seconds.

2. the DDMT composite time standard from 80 percent to 120 percent of the published standard.

3. the type of MCD between smart and dumb.

4. the workload from worst case to an average workload.

V. ANALYSIS

A. Functional Areas. DDMT is broken into five different functional areas where the MCDs will be used. These five functional areas are defined as follows:

1. Bin storage area which includes all bin type actions such as stock selection, stock stowage, and rewarehousing. Normal bin items as well as medical supplies are included in this area.

2. Bulk storage area which includes all bulk type actions such as stock selection, stock stowage, and rewarehousing. Besides the normal bulk items, clothing, textile, subsistence, hazardous, and open shed items are included in this area.

3. Inventory area is not per se a physical area, but includes all inventory and location survey activities.

4. Surveillance area includes all activities associated with stock surveillance and discrepancy reports.

5. Transportation area covers all activities from the time a package leaves packing till it is placed on a truck. For bulk shipping actions this area covers from the time the pallet is picked up off the warehouse floor till it is placed on the truck.

The MCDs are assigned to each functional area as listed in Table 2.

Table 2

MCD ASSIGNMENT

As planned by DDMT

Functional Area	Number of MCDs
Bin Storage Area	169
Bulk Storage Area	217
Inventory	50
Surveillance	17
Transportation	+ 30
Combined	483
Spares	+ 10
DDMT Total	493

B. Workloads

1. Worst Case Workloads. The maximum allowable mainframe response times are based on worst case workloads as defined in attachment 4 of the SPEC. The DLA Depot Operations Support Office (DLA-DOSO), DLA-OW, and DSAC reevaluated attachment 4 during the study; their findings did not differ significantly from the SPEC. The numbers of work activities (i.e., material request orders,

stowing requests, rewarehousing activities, inventory counts, and stock surveillance actions) associated with worst case workloads are shown in Table 3.

Table 3

DAILY WORKLOADS

(in work activities)

Functional Area	Worst Case	Average
Bin Storage	10280	9262
Bulk Storage	9020	8029
Inventory	3450	3035
Surveillance	773	330
Transportation	+ 3800	+ 1562
Combined	27323	22218

2. Average Workloads. The average workloads for DDMT are derived from the actual workloads for each functional area over the last 5 months (Nov. 88 - Mar. 89). The number of activities associated with an average workload are also shown in Table 3.

3. Variances in Workload. The SPEC calls for smart MCDs, which have the ability to operate independently from the mainframe computer and the capability to hold up to ten of the largest transactions. This means a smart MCD can accept many (possibly more than 10) transactions (work assignments) for every one down load (transmission) from the mainframe computer. An average of 10 transactions was used in this study. However, a dumb MCD can not operate independently from the mainframe computer and can only deal with one transaction per transmission. The number of transmissions are based on the workloads in Table 3 and were derived by DLA-OW and DLA-DOSO. They are listed in Table 4. The numbers of transmissions were used in calculating both the maximum allowable mainframe response time and the minimum number of MCDs.

Table 4

DAILY NUMBER OF TRANSMISSIONS

DDMT	Worst Case		Average	
Functional Area	Smart	Dumb	Smart	Dumb
Bin Storage	13785	45026	12143	40359
Bulk Storage	11915	39054	10288	34379
Inventory	3795	13800	3339	12140
Surveillance	1350	4592	593	2010
Transportation	+ 17650	+ 20800	+ 6828	+ 7964
Combined	48495	123272	33191	96852

C. Maximum Mainframe Response Time Results

The maximum allowable mainframe response times initially determined for each functional area and all functional areas combined are shown in Figure 1. They are based on the distribution in Table 2, an MCD response time of 2.5 seconds, and a shift time of 7.5 productive hours. Both smart and dumb MCDs require negative mainframe response times in the bulk storage, surveillance, and transportation areas. The negative response times indicate worst case workloads can not be completed in these functional areas, but not necessarily the magnitude of the workload not processed. However, in bin storage and inventory the maximum mainframe response times can be large, over 2 minutes with smart MCDs. Furthermore, if the total workload is processed without regard to assignment of MCDs to specific functional areas then both smart and dumb MCDs can accomplish a worst case workload if the mainframe response times are 29.1 and 10.0 seconds respectively. Meaning, that the 483 MCDs could be redistributed among the functional areas in such a way as to process all the worst case workload for DDMT. Such an assignment of MCDs will be discussed later. As part of the sensitivity analysis, DLA-OW asked for a comparison between smart MCDs and dumb MCDs. From Figure 1, the smart MCDs allow for a larger margin of error (error in the assumptions or values used) in getting a worst case workload done in one shift. Looking at the functional areas combined, smart MCDs allow up to 29.1 seconds for the mainframe computer to respond as compared to dumb MCDs which allows 10.0 seconds. Hence, smart MCDs provide three times the room for error as dumb MCDs.

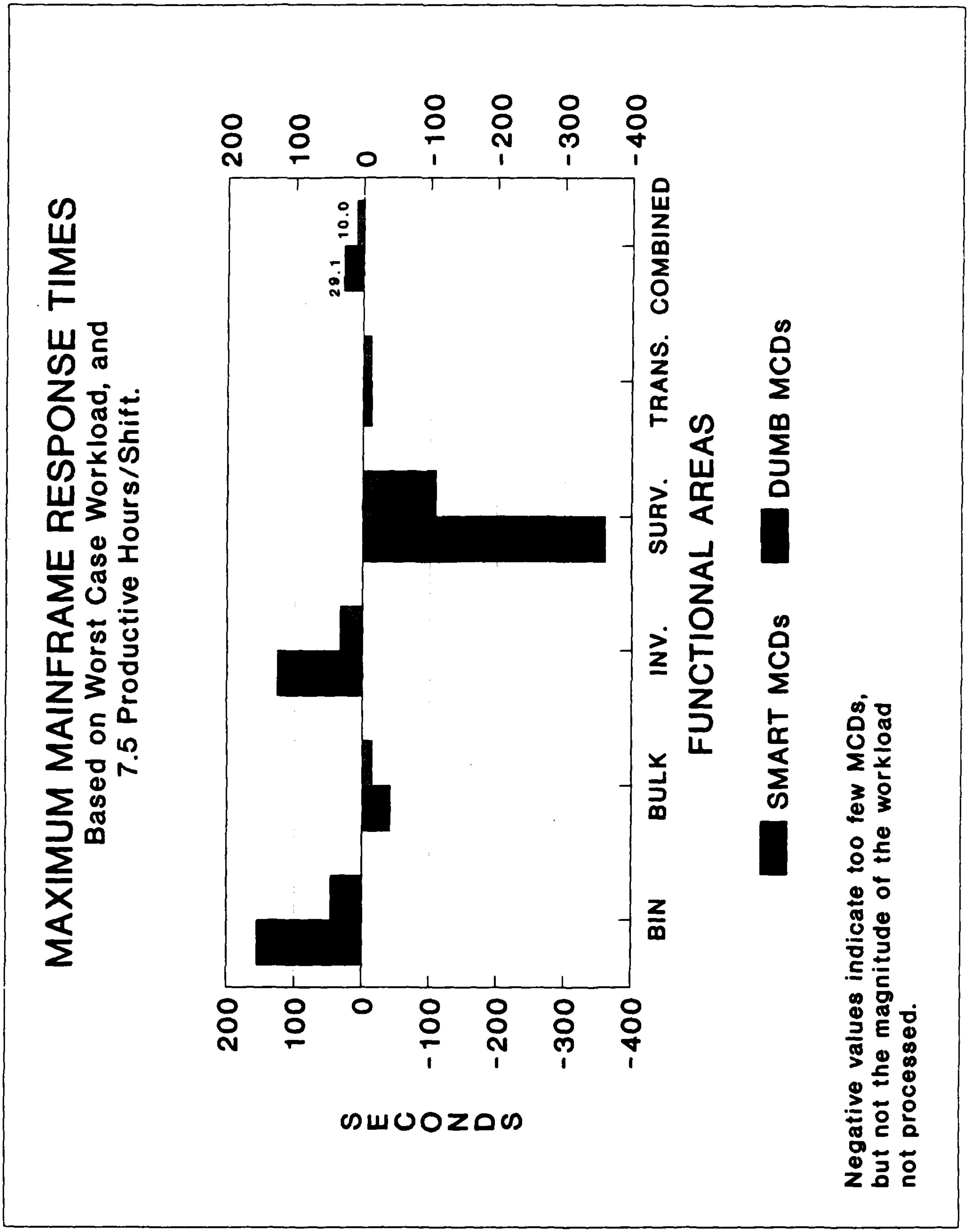
The mainframe response times in Figure 1 were based on 7.5 productive hours in a shift. A shift is 8.5 hours long with a 30 minute lunch break and two 15 minute breaks. Thus a 7.5 productive hour shift requires all remaining time to be wisely used. This is not a realistic view. A 7.0 productive hour shift takes into consideration that there is lost time during a shift, especially at the beginning and end of a shift when the MCDs would be issued or returned. A second maximum mainframe response time was calculated for each functional area. This time the number of productive hours in a shift was set at 7.0. The results are shown in Figure 2.

Again the bin storage and inventory areas were able to complete a worst case workload, but the bulk storage, surveillance, and transportation areas could not. The functional areas combined could complete the workload, even with dumb MCDs, but the mainframe response time would have to be faster than 2.9 seconds. A 2.9 second mainframe response time does not allow much room for error. Using smart MCDs still provides over three times (almost four times) the error margin of dumb MCDs.

D. Results of Minimum Number of MCDs Analysis

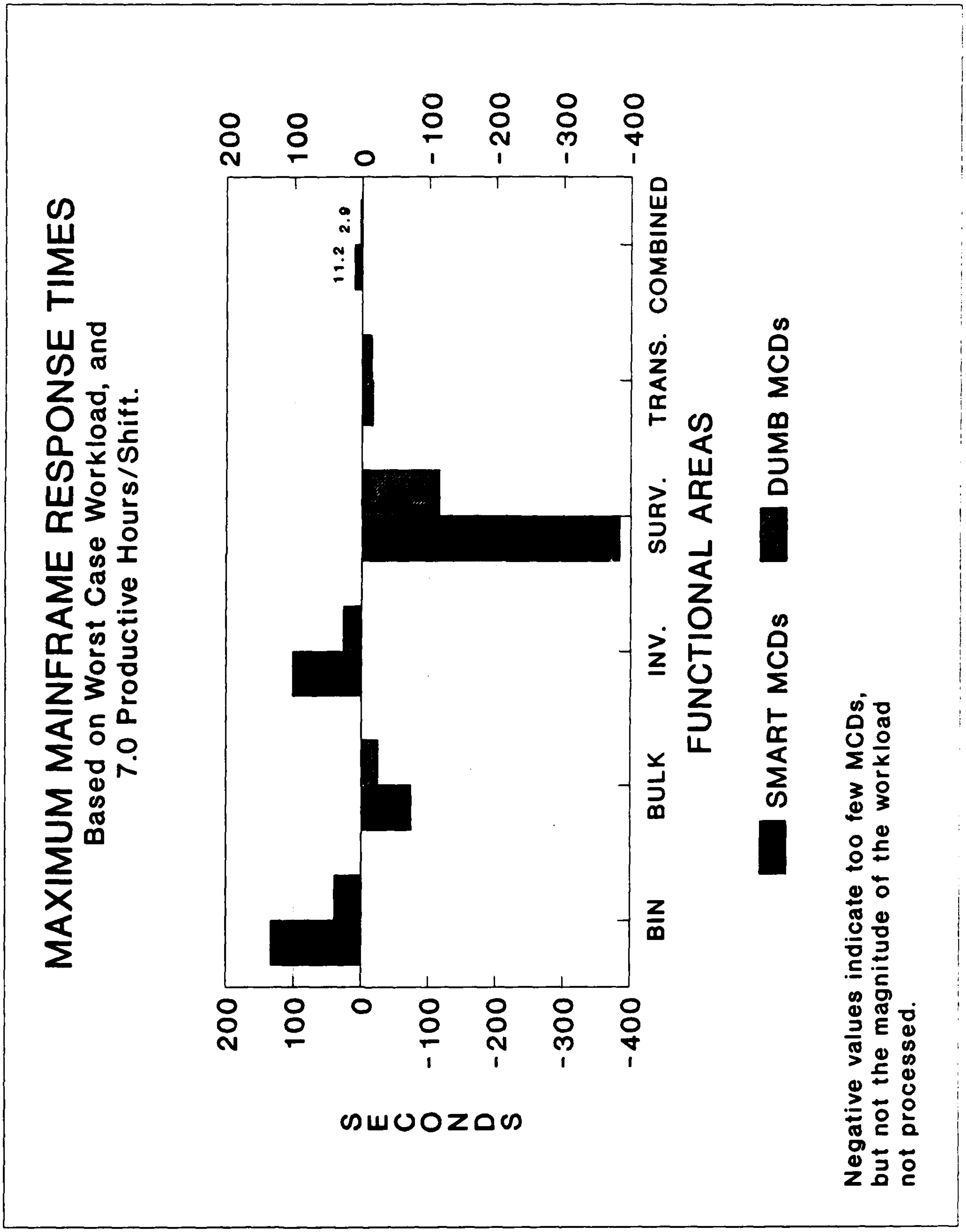
Figures 1 and 2 show that a worst case workload could not be accomplished in the bulk storage, surveillance, and transportation areas for either 7.0 or 7.5 productive hour shifts given the MCDs are assigned per Table 2. However, if the functional areas are combined then the total number of MCDs (483) could get a worst case workload done in both 7.0 and 7.5 productive hour shifts. Therefore, an analysis was done to determine the minimum number of MCDs required by each functional area to process a worst case workload in one shift. A 7.0 productive hour shift was chosen because it is more representative of a typical shift. In order to determine the minimum number of MCDs, the mainframe response time needs to be known. Since the mainframe response time is not currently known, DLA-DSAC was consulted and they estimated a worst case mainframe response time of 5.0

Figure 1



MAXIMUM MAINFRAME RESPONSE TIMES
Based on Worst Case Workload, and
7.5 Productive Hours/Shift.
SECONDS
200
100
0
-100
-200
-300
-400
29.1
10.0
BIN
BULK
INV.
SURV.
TRANS.
COMBINED
FUNCTIONAL AREAS
SMART MCDs
DUMB MCDs
Negative values indicate too few MCDs,
but not the magnitude of the workload
not processed.

Figure 2


MAXIMUM MAINFRAME RESPONSE TIMES
Based on Worst Case Workload, and
7.0 Productive Hours/Shift.
SECONDS
200
100
0
-100
-200
-300
-400
11.2
2.9
BIN
BULK
INV.
SURV.
TRANS.
COMBINED
FUNCTIONAL AREAS
SMART MCDs
DUMB MCDs
Negative values indicate too few MCDs,
but not the magnitude of the workload
not processed.

seconds. The minimum number of MCDs required by each function area are listed in Table 5.

Table 5

MINIMUM REQUIRED NUMBER OF MCDs

Worst Case Workload, 7.0 Productive Hours/Shift, and a 7.5 second System Response Time.

DDMT Functional Area	Smart	Dumb
Bin Storage Areas	99	108
Bulk Storage Areas	255	263
Inventory	36	39
Surveillance	38	39
Transportation	+ 45	+ 46
Combined	473	495
5% Spares	+ 25	+ 26
DDMT Total	498	521

Using smart MCDs, DDMT could accomplish a worst case workload with 473 MCDs. An additional 25 smart MCDs would satisfy the five percent spares requirement, for a total of 498 smart MCDs. If Dumb MCDs are used, then 495 MCDs would be required, which is 22 more than required by smart. An additional 26 dumb MCDs are needed to satisfy the spares requirement for a total of 521 dumb MCDs.

The negative maximum response times in Figure 2 do not illustrate the magnitude of the failure to accomplish a worst case workload. Comparing DDMT's MCD assignment in Table 2 to the minimum required in Table 5 illustrates the magnitude of the inability to accomplish a worst case workload. Table 6 shows this magnitude of failure in the form of percent too many or percent too few MCDs assigned to each functional area. The percentage surplus (negative surplus is a shortage) of MCDs in Table 6 are illustrated in Figure 3.

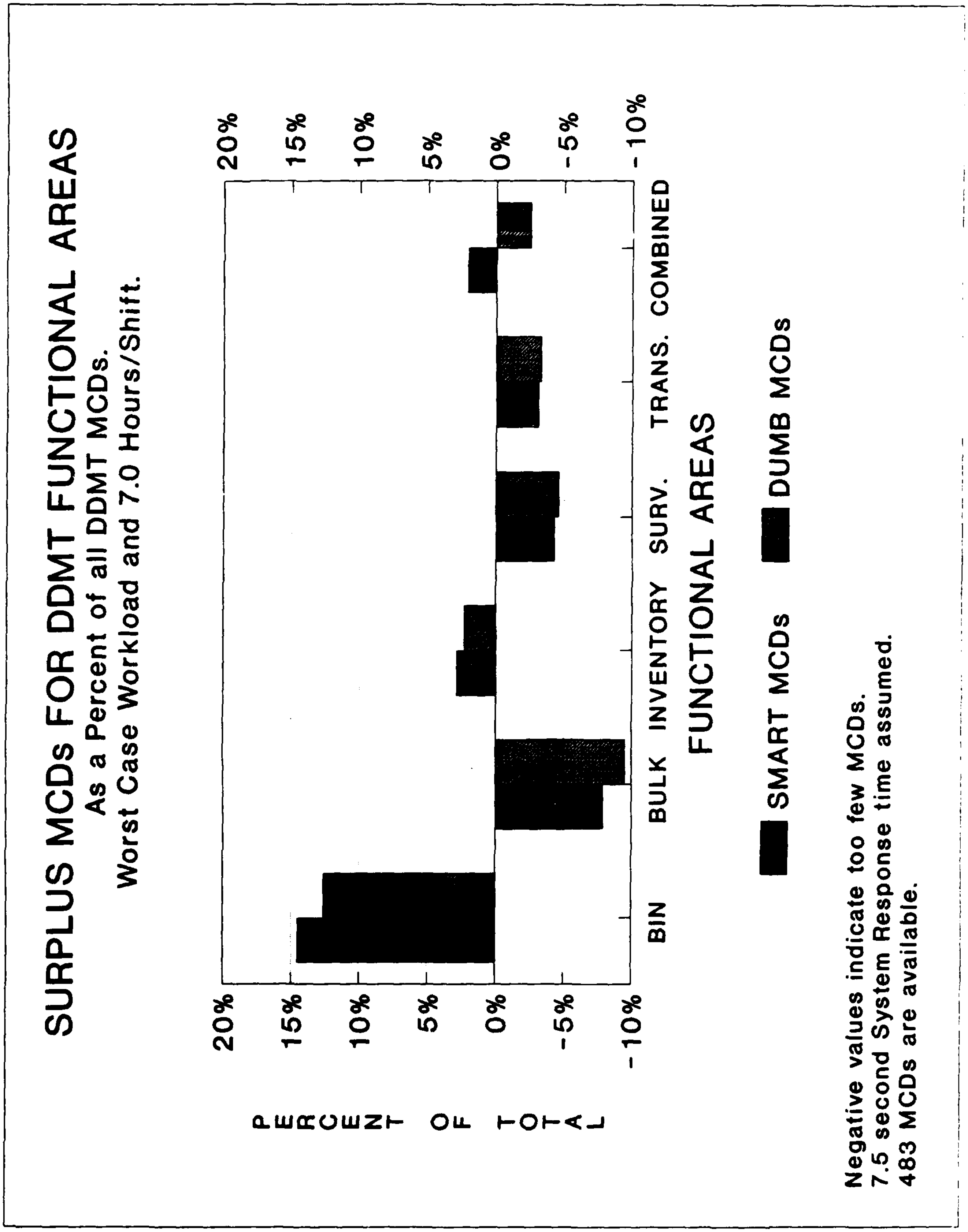
Table 6

PERCENTAGE SURPLUS MCDs FOR EACH FUNCTIONAL AREA

Difference Between Table 2 and Table 5, Worst Case Workload, 7.0 Productive Hours/Shift, and a 7.5 second system response time.

DDMT	Surplus MCDs		Percent Surplus	
Functional Area	Smart	Dumb	Smart	Dumb
Bin Storage	70.0	61.0	14.5%	12.6%
Bulk Storage	-38.0	-46.0	-7.9%	-9.5%
Inventory	14.0	11.0	2.9%	2.3%
Surveillance	-21.0	-22.0	-4.3%	-4.6%
Transportation	-15.0	-16.0	-3.1%	-3.3%
Combined	10.0	-12.0	2.1%	-2.5%

Figure 3



SURPLUS MCDs FOR DDMT FUNCTIONAL AREAS
As a Percent of all DDMT MCDs.
Worst Case Workload and 7.0 Hours/Shift.
PERCENT OF TOTAL
20%
15%
10%
5%
0%
-5%
-10%
BIN
BULK
INVENTORY
SURV.
TRANS.
COMBINED
FUNCTIONAL AREAS
SMART MCDs
DUMB MCDs
Negative values indicate too few MCDs.
7.5 second System Response time assumed.
483 MCDs are available.

The percentages are obtained by dividing the surplus by the total number of MCDs (483 without spares). A positive percentage means there are too many MCDs assigned to that functional area, and a negative percentage indicates too few. Note how the bulk storage area has the largest MCD shortage of all the functional areas. Also, the use of dumb MCDs requires more than 483 MCDs to complete a worst case workload. This dumb MCD shortage can be directly related to the assumption of a 5.0 second mainframe response time. Dumb MCDs required the mainframe response time to be faster than 2.9 seconds. Obviously, dumb MCDs can not complete the workload since the estimated mainframe response time is slower (5.0 seconds) than is required (2.9 seconds).

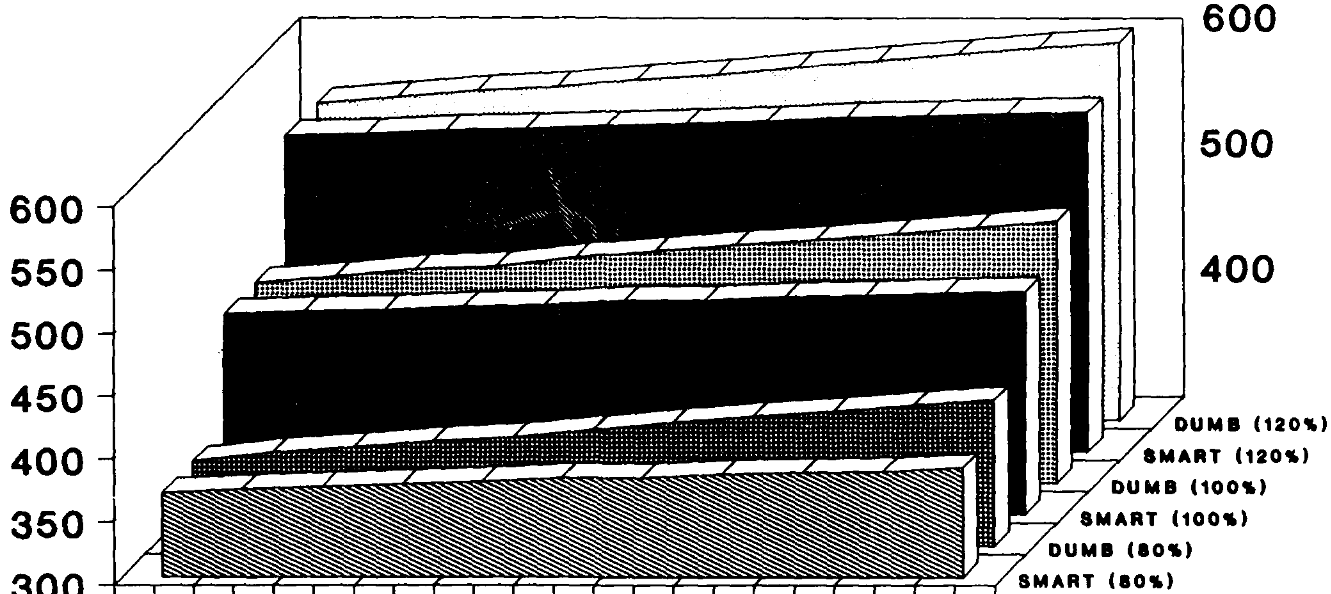
All the calculations up to this point were based on 100 percent of the DDMT composite time standard. The DDMT composite time standard was varied from 80 percent to 120 percent to see how this affects the required minimum number of MCDs (both smart and dumb) for all of DDMT. The results are shown in Figure 4 and are plotted against different system response times (0 - 10 seconds). A worst case workload can be completed at both 80 and 100 percent of the DDMT composite times if smart MCDs are used. Using dumb MCDs, a worst case workload can be processed for an 80 and 100 percent DDMT composite time standard if the system response time is faster than 10 and 5 seconds respectively. A 120 percent DDMT composite time can not be processed given any system response time (0 to 10 seconds) or type of MCD. If the system response time is set to 7.5 seconds then the highest percentage of the DDMT composite time, which allows a worst case workload to be completed, is about 103 percent assuming a 7.0 productive hour shift and only 483 smart MCDs are available. In other words, 483 MCDs are required to process a worst case workload at 103 percent of the time standard, whereas 473 MCDs are required for processing at 100 percent of the time standard. An increase of 3 percent in the time standard requires an additional 10 MCDs. However, such an increase in the time standard is very unlikely, since the activity time standards are conservative and a previous DWASP study concluded that the time standards will decrease by at least 11 percent (DWASP Economic Analysis, May 1987) with the introduction of MCDs. Thus, no more than 473 MCDs are required to process a worst case workload.

Another sensitivity analysis was performed on the minimum required number of MCDs for DDMT. This time, in lieu of using a worst case workload, an average workload was obtained for each functional area over the past five months (November 1988 to March 1989, refer to Table 3). A comparison of the required number of MCDs for worst case and average workloads for each functional area is presented in Table 7. An average workload requires about 90 fewer smart MCDs than does a worst case workload for DDMT as a whole. This is illustrated in Figure 5 across a range of system response times. Considering the magnitude of the difference between average and worse case workloads, the assigning of MCDs should at least start with the minimum number as determined for an average workload for each functional area. If more MCDs are available then they can be assigned in proportion to the average workload.

Figure 4

MINIMUM NUMBER OF MCDs FOR DDMT

Based on Worst Case Workload, and
7.0 Productive Hours/Shift.



	0	1	2	3	4	5	6	7	8	9	10
DUMB (120%)	551	556	561	564	570	574	580	585	590	595	599
SMART (120%)	551	552	555	556	558	560	562	565	566	568	569
DUMB (100%)	459	464	470	472	479	484	489	493	498	503	508
SMART (100%)	459	461	462	465	466	470	470	473	474	476	477
DUMB (80%)	367	374	378	383	386	392	398	403	407	412	416
SMART (80%)	367	370	372	374	376	379	379	382	383	384	387

System Response Time (seconds)

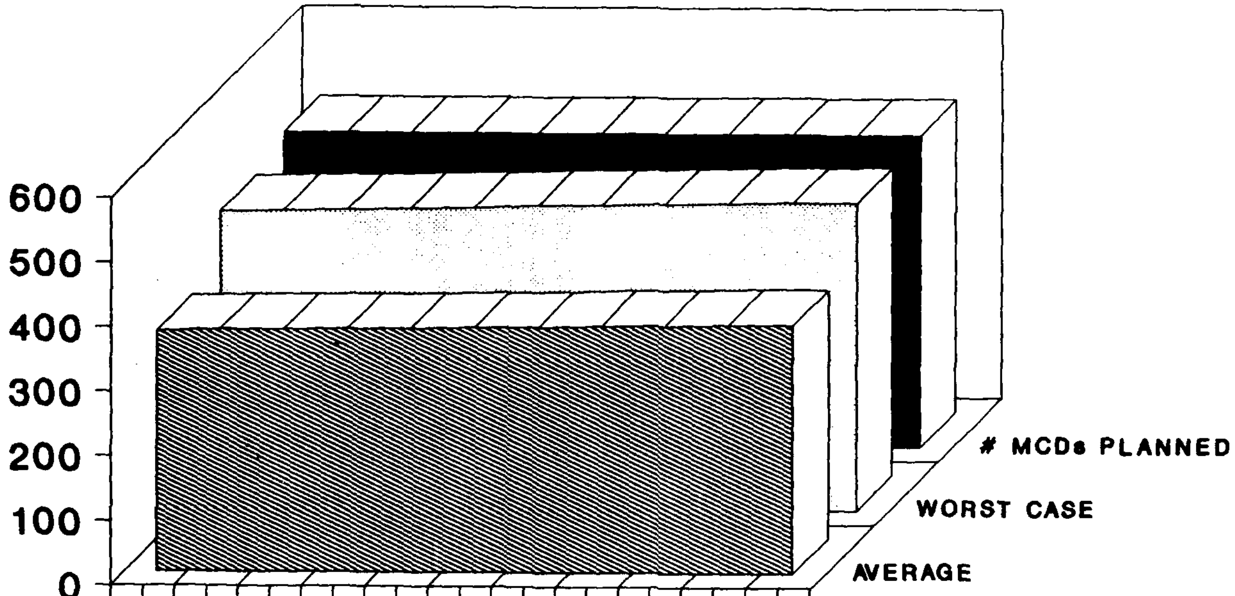
The 80%, 100%, and 120% reflect the
different levels of the Time Standard.

Figure 5

WORST CASE vs AVERAGE WORKLOAD

Based on 7.0 Productive Hours/Shift,
Smart MCDs used, and 100% Time Standard.

NUMBER OF MCDs



	0	1	2	3	4	5	6	7	8	9	10
# MCDs PLANNED	483	483	483	483	483	483	483	483	483	483	483
WORST CASE	459	461	462	465	466	470	470	473	474	476	477
AVERAGE	372	375	375	376	377	379	380	382	383	385	385

SYSTEM RESPONSE TIME (sec)

7.5 second System Response time assumed.

Table 7

MINIMUM NUMBER OF SMART MCDs REQUIRED

Based on 7.0 Productive Hours/Shift, and
7.5 Second System Response Time.

Functional Area	Worst Case	Average
Bin Storage	99	88
Bulk Storage	255	227
Inventory	36	32
Surveillance	38	18
Transportation	+ 45	+ 17
Combined	473	382
5% Spares	+ 25	+ 20
DDMT Total	498	402

E. Summary of Results

A worst case workload can be accomplished with both smart or dumb MCDs provided the mainframe response time is faster than 10.0 seconds and warehouse laborers work productively for 7.5 hours of their shift. A 7.5 productive hour shift does not allow for any lost time during the entire shift. A 7.0 productive hour shift is probably more realistic, but then the mainframe response time must be faster than 2.9 seconds in order for dumb MCDs to complete a worst case workload, which is highly unlikely given the DSAC estimate of a five second mainframe response time. Thus, dumb MCD's cannot process a worst case workload during a 7.0 productive hour shift. Smart MCDs only require a 11.2 second mainframe response time. Hence, smart MCDs can process a worst case workload during a 7.0 productive hour shift and provide a greater margin for error, almost four times that of dumb MCDs. Thus, smart MCDs should be procured.

Furthermore, with a minimum of 473 smart MCDs a worst case workload can be completed in a 7.0 productive hour shift over a reasonable range of system response times (0 to 10 seconds). An additional 25 MCDs, for a total of 498 MCDs, would meet the SPEC requirement that 5% of all MCDs are to be spares.

Distributing MCDs according to DDMT's numbers (Table 2) causes shortages to occur in bulk storage, surveillance, and transportation areas. If the MCDs are distributed per worst case workload then some functional areas will receive proportionally more MCDs than their average workload would suggest (Table 7). But if the MCDs were proportionally distributed according to a functional area's average workload, then there would be enough MCDs available if daily workloads increase.

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Increment III of the DLA Warehousing and Shipping Procedures (DWASP III) includes switching the depot functions of stock selection, stowage, inventory, stock surveillance, and transportation over to a paperless system. This will be accomplished by using Mobile Communication Devices (MCDs) to link warehouse workers with the depot mainframe computer. The volume of transactions between warehouse workers and the mainframe computers affects the mainframe response time. This study was performed to determine the maximum allowable mainframe response time and the minimum required number of MCDs that would allow Defense Depot Memphis Tennessee to process a worst case workload in one shift.

14. SUBJECT TERMS
Warehousing, Shipping, Mobile Communication Devices

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